Affective adaptation design for better gaming experiences

Ollie Hall
Salma ElSayed

This is the Authors' Accepted Manuscript of a conference paper to be published in the proceedings of the 15th International Conference on Computer Science and Game Design, 28-29 October 2021, Paris, France

Affective Adaptation Design for better Gaming Experiences

Ollie Hall, Salma ElSayed

Abstract— Affective adaptation is a creative way for game designers to add an extra layer of engagement to their productions. When player's emotions are an explicit factor in mechanics design, endless possibilities for imaginative gameplay emerge. Whilst gaining popularity, existing affective game research mostly runs controlled experiments in restrictive settings and rely on one or more specialist devices for measuring player's emotional state. These conditions albeit effective, are not necessarily realistic. Moreover, the simplified narrative and intrusive wearables may not be suitable for players. This exploratory study investigates delivering an immersive affective experience in the wild with minimal requirements, in an attempt for the average developer to reach the average player. A puzzle game is created with rich narrative and creative mechanics. It employs both explicit and implicit adaptation and only requires a web camera. Participants played the game on their own machines in various settings. Whilst it was rated feasible, very engaging and enjoyable, it remains questionable whether a fully immersive experience was delivered due to the limited sample size.

Keywords— affective games, dynamic adaptation, emotion recognition, game design.

I. Introduction

The ability of computers to be "intelligent enough to extract the user's commands by their behavioural cues and emotional states" [1] has been a hotly discussed topic with researchers striving to understand the implications of such autonomy. The concept and systems based around it was introduced as *Affective Computing* [2]. Although biofeedback systems were often aimed at task automation and emotion regulation [3], ludology has been a rapidly growing sandbox for affective adaptations experiments. The term coined *Affective Gaming* explores digital games able to recognize the emotional state of a player and alter the gameplay accordingly.

Ideally, games designers aim for their productions to engage players enough to achieve immersion whilst sustaining flow [4]. Despite seldomly being approached with classic game principles and patterns in mind, affective games are no different. In fact, it is established that adding an affective dimension into games design, improves player experience, especially with clever engaging adaptations. Nevertheless, affective games face several challenges and pose additional demands regarding design, implementation, and testing requirements. These issues have been examined in [5] and [6], realising the main adaptation targets as content generation, adjustment, and non-player character (NPC) adaptation.

Ollie Hall and Salma ElSayed* are with Abertay University, Dundee, DD1 1HG, United Kingdom (*corresponding author, e-mail: 1700066@abertay.ac.uk, s.elsayed@abertay.ac.uk).

II. Motivation

The majority of affective games experiments benefit from multimodal affect information by fusing behavioural cues from the player's face and body with their physiological responses like heart rate and skin conductance. This consequently requires various kinds of sensing devices, of which, at least one is likely intrusive. In addition to capturing players focus via interactive mechanics and noticeable NPC reactions, the more subtle game world elements of gameplay are crucial to influencing the emotions of the player. These include visual and auditory elements that contribute to the overall atmosphere of the game and are often overlooked or underrated by participants in restricted affective experiments, especially in the presence of more interactive content or emotionally aware NPCs. Moreover, the controlled experiment settings combined with the understandably simplified game world and adapting elements, heavily shear down the inherent feeling of "gaming".

This paper explores the prospect of producing an affective experience via dynamic audio-visual elements, rich 3D game world, and engaging mechanics, whilst still being accessible to the casual player and bring an enjoyable time. The design process is informed by affective game design principles in the literature. The created game is more akin to that of 'The Witness' [7]; having the player progress through solving puzzles and exploring rather than combat and fast actions.

There is little research to guide game developers on how players respond to changes to different aspects of a game such as the character, enemies, or environment. This makes affective games difficult to design as the outcome of the design is unpredictable [8]. Therefore, a simplified approach to target universally established facial responses is adopted in this study. The game only requires a web camera to perform Facial Expression Recognition (FER) from player's *acted faces* in an attempt to involve them emotionally in the game. It is designed for Windows operating systems and has been tested "in the wild" as an empirical study of the suitability of such approach.

It should be noted that the study focusses on the feasibility of the proposed affective adaptations in delivering a realistic gaming experience via content adjustment only, with the exception being the puzzle elements within the game. Difficulty and NPC adaptations are not investigated for affective adaptation within this work. It is hypothesised that such affective adaptation design would still have an impact on the gaming experience. Section III outlines the design and creation of the different components of the application including the emotion recognition model and affective adaptation within the game. It also discusses details of testing and data collection. In Section IV, an evaluation is given for the designed systems via quantitate and qualitative measures. Related work is addressed in Section V and conclusions are presented in Section VI.

III. METHODOLOGY

The following sections describe the components of the affective loop designed for the experiment. It consists of an emotion recognition model, game logic, and the adaptation mechanisms reacting to the identified emotions.

A. Real-time FER

The application is expected to be constantly performing calculations and rendering tasks to run the game, putting high computational load on the CPU/GPU. Therefore, it is important that the FER module is as efficient as possible for a smooth and comfortable gameplay experience. It is also desired that any extracted features are inexpensive whilst still providing enough data to accurately predict the player's exhibited expression. With the assumption that players are directly facing the camera in a casual gaming pose, a light-weight bespoke machine learning model was externally developed that relies on facial landmarks [9] and was trained on large image sets of frontal faces [10] to classify seven emotions: joy, sadness, disgust, fear, surprise, and anger. The trained model is subsequently loaded into the game application and a prediction engine is created based upon the model's data.

To be able to detect the player's facial expression, their face needs to be located from the webcam feed. The captured frames are downscaled and grey scaled to reduce processing time, and contrast is adjusted for better image clarity. This pipeline eventually converts the image frame into a processed array of pixels to be used by the detection library. The face locator is computationally intensive, so the process executes every 5 seconds rather with every frame. However, this creates a frame drop, resulting in a less than ideal stutter. Whilst being a key factor, it was decided that for this study, the facial detection technology is not to be prodded further in an attempt to restrict the processing demands, and rather focus on delivering affective experiences with accessible requirements.

As the subject's emotion is evaluated multiple instances per second, there are often miscalculations and outliers. This affects the game experience by representing an emotion to the player that they were not exhibiting. To account for this, emotions are aggregated to find the modal average emotion. Recently predicted emotions are stored in a queue, and the frequent emotion within this queue is used for the affective adaptation system. This allowed for smoother, more natural adaptation.

B. The Game

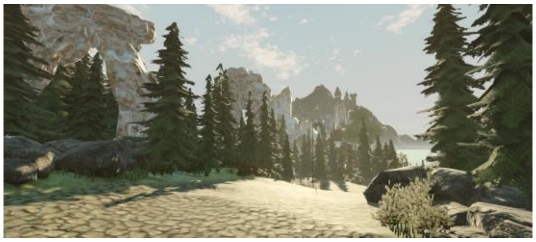
The created game, "Ardentide Island", has one level that allows the player to explore an island and solve three puzzles using acted face expressions. Moreover, the game world passively changes to reflect the player's current affective state inferred from their face. These include an adaptive weather system, dynamic post-processing, and reactive wildlife. Developed in Unity engine, the game runs on Windows operating systems and only requires a web camera to perform FER. The High-Definition Render Pipeline (HDRP) is used as the render pipeline within Unity, allowing high fidelity graphics, volumetric fog, and physically based lighting. A metrics system is built into the game for evaluation. Data is gathered on the player's affective state, location and time it was exhibited during playing. These metrics are used to infer statistics such as modal emotions, duration, and preferences. The game can be completely played offline, and no video or any identifying information about the player is extracted or stored.

C. Affective Adaptation

Two different modes for affective adaptation exist within the game – Reinforcement and Support. When on Reinforcement mode, elements of the game adapt to match the player's exhibited emotion. The intention of emotional reinforcement is to enhance the immersive quality of the game experience. The Support mode, on the other hand, exists to create a more lightly-therapeutic experience for the player – if they are exhibiting sadness, anger or fear, the affective system will adapt to alleviate these emotions and bring the player to either a more neutral or joyful state. This mode explores the concept of using affective adaptation more passively, and how it can be utilised to subtly improve a subject's mood, rather than directly being a result of the player's affective state. This mode possesses a fundamental flaw: the game world will not adapt to represent emotionally negative elements in the environment, and this has the potential to suppress immersion and undermine games with story-telling elements that may want to reflect emotions other than joy in their surroundings. For this study, with the nature of the designed quests, only the Reinforcement mode was tested by participants to evaluate its effectiveness in producing an immersive game, and its influence on player's mood.

D. Adaptive Environment

Within art, literature, and media, weather is commonly used to represent emotion. It is closely linked with mood and can stimulate thoughts and feelings that are associated with the weather's atmosphere, sunlight, and rainfall. A dynamic system is created for Ardentide Island that alters the weather in the environment based on the player's affective state. The system allows for light and heavy rainfall, volumetric fog, variable cloud density and colour, and different times of day. If the player exhibits an affective state resembling that of sadness using the Reinforcement mode, the atmosphere of the environment darkens, a heavy fog slowly forms, and rain begins to pour down. On the contrary, if the player exhibits a positive state such as that of happiness, the skies clear and the sun shines. This results in vastly different visuals based on the player's emotions, and audio such as the sound of rainfall enhances this feeling of atmosphere and mood further. Flocks



(a)

(b)

Fig. 1 Samples from two areas on the island.

of birds in the sky above the island have variable speeds that are tied to affective state – if the player is exhibiting the emotion of fear, the birds fly faster, making the sky appear more foreboding. Whilst being an important contribution to the richness of the adaptation, the system may appear unrealistic at times, as the weather could change erratically and frequently depending on the player's shift in emotion.

E. Adaptive Audio and Visuals

Affective adaptation of audio was explored and is present within the game to an extent – audio from the environment, such as birdsong, cicadas, and other ambient sounds, have dynamic volume that changes according to the player's affective state. For example, if the player exhibits fear, all environmental sounds fade away, conveying a feeling of isolation and disturbance. This system can be improved in future investigations to accommodate dynamic music and audio, implementing a variety of adaptive music pieces that reflect the player's mood, or elements of the game that emit distinct sound effects relevant to mood change.

A subtle yet significant element of the game's adaptive visuals is the post-processing. These include vignette, lens distortion and white balance. White balance is used as a tool to represent happiness and sadness – the colours of the screen become warmer or colder respectively. When the player exhibits disgust, the camera lens distorts to convey the feeling of nausea. When the player is angry or fearful, a vignette gradually closes in around the camera to represent darkness and tunnel vision – a loss of peripheral vision often caused by fear or distress. The affective post-processing works as an extension and enhancement to the affective weather system, further influencing the mood of the game, whilst adding new variety to emotions such as fear and disgust.

F. Level Design

The level is designed to be non-linear – less focused on tasks and interaction, and more focused on exploration and environment. The player begins in the centre of the level and can walk down three routes leading to different regions with one puzzle each. Two areas are shown in Fig. 1. Each has a distinct environment and unique events triggered depending on the player's affective state. For example, if they exhibit joy in the forest area (Fig. 1a), they may see eagles flying out of the trees into the sky. This design allowed for experimentation of affective adaptation within multiple different environments and showcases how the system can operate in many themes. There are no NPCs, enemies, or threats to the player, encouraging them to take their time to play the game and explore the island. The player may use a keyboard and mouse, or a gamepad to play the game. Within a single playthrough, the player must visit each region to solve three puzzles to collect "relics" that unlock a portal in the centre of the island – the player's starting point. The game is completed upon the player solving all three puzzles and entering the central portal.

G. Puzzle Design

The puzzles within the game are carefully designed around the affective mechanics. Complementing the more passive affective adaptation experienced throughout the rest of the game, the player must actively exhibit affective states to complete puzzles. The three puzzles revolve around the concept the Mind, Body and Soul. For the Mind puzzle, the player must use a cube of mystical energy to direct a beam of positive or negative energy into four floating orbs to balance their states (Fig. 2a). For the Soul puzzle, the player peers into a mirror and exhibits emotions prompted by its represented text (Fig. 2b). For the body puzzle, the player must navigate through a labyrinth of emotion-based gates to find the "heart" of the maze (Fig. 2c).

A meta-analysis established that facial expressions have a small impact on feelings, and smiling makes people feel happier, or frowning makes them sadder [11]. The design of the puzzles to directly elicit facial expressions from the player allows them to experiment with their emotions and possibly even improve their mood. The Mind puzzle requires the player to exhibit either positive or negative affective states to influence the outcome, and the player can decide what emotion to exhibit to represent positivity or negativity. This puzzle provides the means for the player to explore what they perceive as positivity or negativity, and possibly provides light therapeutic benefits by allowing players to exhibit affective states that may not be socially acceptable in any other circumstance. The act of pulling certain facial expressions to complete tasks is also an amusing one, and the entertainment factor of the puzzles intends to further the player's engagement with the game and therefore increase the immersive quality of the experience.

H. Data Collection

In-game Metrics: A system is implemented into the game to allow for the collection of statistics on the performance and behaviour of participants. The metric system records data from 10 different areas on the island, using simple trigger box colliders to detect when the player either enters or exits each

(a) Conveyance (Mind) (b) Mirror (Soul) (c) Labyrinth (Body)

Fig. 2 The three puzzles.

area. The time spent in each area, the elapsed time since starting the game, and changes in predicted emotions are also recorded, along with a breakdown of which emotions were detected at each area. The data are logged in a text file inside the game folder and is the only information exported from the session.

Questionnaire: Participants filled a 14-question survey upon completion of the game. The questionnaire uses multiple-choice and 5-point Likert-scale for the player to score their experience between 1 (not at all) and 5 (extremely). Optional free-form text elaboration is allowed for three of the questions. The survey is designed for feedback covering three main dimensions: overall enjoyment of the game; the effectiveness and noticeability of the affective adaptation in creating/enhancing immersion, and how it influences the participant's mood or awareness of their affective state.

Participants: The game is made available on a public page with explanation on how to proceed with the study. Participants are briefed on the premise of the experiment and to sign a consent form. Instructions are given to download and play the game, and it is explicitly clarified that the gameplay and camera capture are not recorded. Participants would play the game on their own systems using the reinforcement mode, then complete an online survey and send the metrics file. All data are anonymised upon collection.

IV. EVALUATION

A. Metrics

The current sample consists of data from 18 participants who were sent the game link directly. It was important that they are not asked to avoid exaggerating emotional displays, as it is desired for them to play the game naturally and without bias as if they were an average player. The game data is available from only 16 play sessions.

The most frequent affective state expressed by the collected data was "Joy", being exhibited for 20% of the average playthrough of the game and making up 40% of all emotions exhibited in an average playthrough. "Sadness" occurred 14% of an average playthrough, being 29% of all exhibited emotions. "Fear" was expressed with 6% frequency, followed by "Anger", "Disgust" and finally "Surprise". The neutral affective state was excluded from the analysis due to the imbalance caused by the participants' resting face during prolonged exploring times.

Since the maze puzzle is the only area where participants are explicitly instructed to act certain emotions, it appears that when given the freedom to act any emotion, participants expressed joy, most likely by smiling. Moreover, in sequences when they should act less certain emotions to progress in the game, players naturally smiled or frowned as the most natural way to express positive and negative emotions, respectively. This combined with the fact that in Ekman's universal emotion system, joy appears the only positive emotion in the list, puts the joy detection rate above the others.

Fig. 3 shows which areas had the most frequency of emotions overall, and the most and least frequently exhibited emotions per area. These areas do not include the puzzle areas themselves, only the pathways leading to them. Inclusion of the puzzles would imbalance the results as the Body puzzle has longer duration compared to the other two. It also encourages more frequent and varying affective states.

The section of path leading towards the maze puzzle, had the highest frequency of change in affective states for participants. This could be due to the fact that the path lies straight ahead from the starting area, rather than the other paths that have the player turn left or right, resulting in the path being the first one the participants pick. Also, knowing the affective adaptation exists, many participants were interested in experimenting with different facial expressions, resulting in a high frequency of affective exhibition at the beginning of the game.

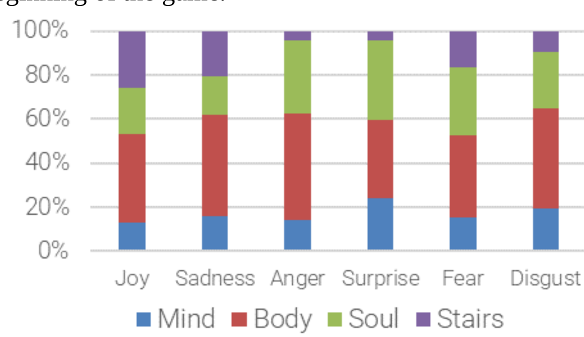


Fig. 3 Frequency of affective states per area.

B. Game Performance

Whilst the HDRP had its appealing advantages, its high fidelity also meant that the game's performance was far less than desired, with 75% of participants finding the low performance noticeable. This is important as poor performance can frustrate and/or distract the player from the experience, potentially ruining any sense of immersion or engagement they had. It is recommended that a more supported render pipeline is used to avoid these problems.

The sole source of affective input in Ardentide Island was a webcam to capture the face of a player. This provided means for the application to detect and evaluate the player's emotion without being too intrusive. Even when this was effective enough to provide a proof-of-concept, the system may have been more beneficial with more inputs, such as biometric peripherals, or other forms of in-game data. A wearable heart-rate tracker would have allowed for more accurate detections of subtler emotions such as fear and surprise which may not manifest as particularly obvious facial expressions when playing a video game. However, that would not have been suitable for the current puzzle design since players cannot adjust their physiological signals on cue.

Many participants had resting faces that would be falsely recognised as sadness, fear or even disgust, as these expressions are subtle changes from a neutral face. The image dataset used for training the facial detection model widely used in FER literature, but it must be noted that facial expression detection based on such datasets is unreliable in gaming setting and the effectiveness of the prediction varies greatly between subjects. Gaming oriented or webcam-captured images sets would be more relevant to the context of the model. Personalised models could be a potential improvement to address false identification of facial expressions, especially with the participant's resting face and diverse testing conditions [12].

The emotion aggregation module needed to be balanced carefully – the longer the list of recent emotions, the more accurate the average calculated emotion is, but the system will take longer to calculate a new emotion. If the aggregator stored 20 recent emotions, and the player switched from "joy" to "sadness", it would take 11 registers of "joy" to decide it the average emotion, resulting in too long a wait for the affective adaptation. On the other hand, if the list of recent emotions were too short, the processing time would be brief, but the average emotion would not be very accurate, and would fluctuate relatively frequently. The chosen size of the list for the final build was 6 recent emotions, as it struck a fair balance between accuracy and speed.

Overall, the facial expression detection system worked relatively well for the exploratory study, but there are opportunities to streamline and improve its ability for a more reliable and seamless experience.

C. Survey

As participants played the game remotely, this resulted in webcams of differing quality, varying light conditions, and different hardware running the game. Despite that a controlled experiment settings may have produced better results, testing the affective adaptation in the wild is more authentic and the variety of test conditions resembles those a marketed affective game would produce. Survey ratings for immersion and game performance, and affective adaptation influence, are listed in Tables I and II, respectively.

Immersion: The survey shows that all 18 participants enjoyed the game, and 83% of them found the experience engaging to extremely engaging. Half of the participants (9:18) thought the affective adaptation "may" have immersed them more into the game, with the remaining scores between "yes" (7:18) and a minority of "no" (2:18). Admittedly, this question is controversial, as immersion is hard to measure or even understand. If one is immersed in an experience, ideally, they should not be aware they are immersed but would be completely absorbed by the experience itself. Since immersion is a difficult factor to calculate, these results are not entirely conclusive especially with the small sample size.

Overall, participants expressed that they found the mechanics "fun" and "enjoyable". One participant suggested that the game may be more entertaining if played with other people in the same room – affective adaptation could provide entertainment in the party game genre, having players expressing certain emotions to fulfil tasks to the amusement of their peers.

Performance: this rating had a 4-point Likert score as shown in Table I. All participants confirmed noticing the affective adaptation to varying degrees, with half of them thinking it was "extremely noticeable". Whether or not the game adaptation should be evident to players [13] really depends on the design of the experience. They could supplement or enhance the base game with less obvious changes or be fundamental to the game's design. Ardentide Island uses implicit affective adaptation to subtly alter sound, change post-processing effects and change the weather, but affective adaptation is also employed as an explicit tool for puzzle-solving – in this case a participant must at least notice those and cooperate with the system to complete the game. Roughly a third of the participants (5:18) found game performance to be "very noticeable and jarring" in terms of playability and framerate. Rating varied due to the different system configurations the game ran on across participants. An obvious association is observed between poor game performance and less immersion in the survey data.

Mood: It is observed from Table II that a majority (13:18) reported the experience to influence their mood, of which, two players experienced this "very noticeably". Free-form comments clearly indicated how interacting with the affective adaptation system by "pulling faces" affected the mood of the players by smiling or laughing. It is also conceivable that some participants were frustrated with their experience due to problems with the affective adaptation, and therefore marked that their mood was influenced. Whilst many had difficulty with exhibiting required emotions for progressing in the puzzles, all participants were able to express joy and sadness with ease. On the other hand, 38% (7:18) felt that the experience made them more aware of how they are feeling. A game that could bring awareness to the player's underlying affective state could be used as a tool for light therapeutic benefits. This bears resemblance with 'Nevermind' [14] where player's stress and anxiety are linked with the intensity of the experience, forcing players to manage these feelings to win the game.

TABLE I
SURVEY RATINGS FOR IMMERSION AND GAME PERFORMANCE

Participant	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Mean	S.D.
Game performance	4	2	2	4	4	2	3	3	3	2	3	3	4	3	4	3	3	3	3.16	0.75
Immersed more	N	Y	M	Y	M	M	M	M	Y	Y	M	N	M	M	Y	Y	Y	M		

Reference: 1 = not noticeable, 2 = slightly but not an issue, 3 = somewhat noticeable, 4 = very noticeable and jarring.
N = No, M = Maybe, Y = Yes.

TABLE II
SURVEY RATINGS FOR ENGAGEMENT AND AFFECTIVE ADAPTATION INFLUENCE

Participant	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Mean	S.D.
Engagement	3	4	5	4	4	4	3	3	4	4	4	4	4	4	5	4	5	4	4.00	0.58
Affective Adaptation	4	5	3	5	4	5	4	3	4	4	5	5	5	5	4	5	5	3	4.33	0.75
Awareness of feelings	1	4	3	4	2	3	3	4	3	4	4	3	2	2	3	3	4	5	3.16	0.96
Influence on mood	4	4	2	4	4	3	4	4	2	5	4	4	3	4	5	4	4	2	3.67	0.88

Reference: 1 = not at all, 2 = I don't think so, 3 = not sure, 4 = yes, 5 = very.

Puzzles: The dynamic weather was the favourite affective adaptation amongst participants, followed by the "body" puzzle and "mind" puzzle in joint second. Survey comments highlighted the interesting dynamicity of the weather and how it changed "naturally" or "added to the immersion". One participant said, "It brought a level of dynamics into the aesthetic of the game which for me was the most interesting bit". The affective weather system was created as the main overarching element of the environmental adaptation, so the success of this system is satisfying and helps inform how affective adaptation could be more effective in terms of game world elements. The "body" puzzle was found to be both challenging and fun because of its spatial gameplay. Whilst the remaining two puzzles freeze the player in a fixed position as they solve using their emotion, the maze provides a space for the player to explore, providing a more dynamic experience.

Ethical Concerns: A few participants raised the concern of the intrusive quality of the game. Although the game is played offline, and their privacy was assured in the experiment with no data being recorded other than timestamps and text equivalent of precited emotions, many participants expressed dislike to the idea of affective adaptation being used by game companies or corporations, as it would provide them access to players' webcams. This is an important topic to raise, as privacy concerns rise every year alongside corporate distrust.

V. RELATED WORK

A handful of video game experiences have attempted to understand and adapt to the player's mood through different methods to achieve certain results. Flying Mollusk's 'Nevermind' [14] is biofeedback-enhanced horror game that encourages players to become aware of their anxiety levels as the game adapts to their heart rate. Players are rewarded for being able to manage that anxiety "on the fly". The game is playable with or without the camera and heart rate monitor and is a rare example of a fully affective loop in a production.

Another affective survival horror game was designed by [15] and is based on the 2012 game 'Slender: The Eight Pages' [16]. Two versions of the game were created: a standard experience with no affective elements, and the affective version that has the 'slender man' pursue the player based on their affective input. The placebo element helps gather information on the effectiveness of the affective game in comparison to the standard experience. It is important to note here that due to the nature of the quests involved, a completely non-affective experiment cannot be tested for Ardentide Island. A version of the game that disables the game world adaptations could have been tested to evaluate whether there's a significant difference in participant immersion between the two experiences. However, the very small sample size and duration of gameplay hindered the decision to run a control experiment.

The analysis in [17] ran a study with the puzzle game LittleBigPlanet 2 [18] and concluded 15 suggestions for affect user-centred game design. Table III shows how Ardentide Island design establishes the majority of these components.

TABLE III
COMPONENT OF USER-CANTERED GAME DESIGN [17] FOR ARDENTIDE ISLAND

Player Preferences		Narrative	✓
Player Skills		Characters	
Pacing Difficulty		Game Interface	✓
Goals	✓	Ease Controls	✓
Rewards	✓	Tutorials/Hints	✓
Interactive Environment	✓	Reduce Lagging	
Graphics Quality	✓	Flexible Options	
Creativity	✓		

VI. CONCLUSION

As technology within the video game industry improves, developers are striving to further immerse players within their games using new techniques. With recent video games breaking the boundaries of emotional storytelling with the use of state-of-the-art technology, understanding and manipulating the mood of the player is important for creating immersive, engaging, and perhaps even therapeutic experiences.

Affective adaptation has limitless potential within the games industry. With large teams and budgets, games could be made with multi-modal affective inputs from different sensors, allowing for even more diverse mechanics and gameplay. Plausibly, privacy is a concern as ethical barriers rise with having access to players biometrics.

Nevertheless, it is safe to conclude that affective games have the capacity to create entertaining experiences that are very affordable to the average designer and customer. This study is informed by user-centered designs that rely on ubiquitous, non-intrusive equipment, authentic gaming conditions, in an environment of polished aesthetics and unique mechanics. With the limited pool of participants and lack of a control study, it remains inconclusive if players were immersed more because of affective adaptation. Still, the study showcases that at the very least, it introduces a layer of fun engaging interaction.

Ardentide Island stands out as an example of a genuine experience that not only works as a research project, but also as a fully deployable game. It presents an exciting step for affective adaptation and promotes such interactions to indie designers for crafting captivating experiences into their games.

References

[1] Kotsia, Irene, Stefanos Zafeiriou, and Spiros Fotopoulos. "Affective gaming: A comprehensive survey." Proceedings of the IEEE conference on computer vision and pattern recognition workshops. 2013.

[2] Picard, Rosalind W. Affective computing. MIT press, 2000.

[3] Jerčić, Petar, and Veronica Sundstedt. "Practicing emotion-regulation through biofeedback on the decision-making performance in the context of serious games: A systematic review." Entertainment Computing 29 (2019): 75-86.

[4] Michailidis, Lazaros, Emili Balaguer-Ballester, and Xun He. "Flow and immersion in video games: The aftermath of a conceptual challenge." Frontiers in Psychology 9 (2018): 1682.

[5] Hamdy, Salma, and David King. "Affective games: a multimodal classification system." 19th annual European GAME-ON Conference (GAME-ON'2018) on Simulation and AI in Computer Games. EUROSIS, 2018.

[6] Hamdy, Salma, and David King. "Affective games: adaptation and design." 20th annual European GAME-ON Conference: Simulation and AI in Computer Games. EUROSIS, 2019.

[7] Thekla Inc. CA, USA, 2016. The Witness. [Disk]

[8] Kuikkaniemi, Kai, et al. "The influence of implicit and explicit biofeedback in first-person shooter games." Proceedings of the SIGCHI conference on human factors in computing systems. 2010.

[9] Munasinghe, M. I. N. P. "Facial expression recognition using facial landmarks and random forest classifier." 2018 IEEE/ACIS 17th International Conference on Computer and Information Science (ICIS). IEEE, 2018.

[10] Kanade, Takeo, Jeffrey F. Cohn, and Yingli Tian. "Comprehensive database for facial expression analysis." Proceedings Fourth IEEE International Conference on Automatic Face and Gesture Recognition (Cat. No. PR00580). IEEE, 2000.

[11] University of Tennessee at Knoxville, ScienceDaily, "Psychologists find smiling really can make people happier.", April 12, 2019. Accessed on: 20 April 2021. [Online] Available at: www.sciencedaily.com/releases/2019/04/190412094728.htm (Accessed 20 April 2021)

[12] Kutt, Krzysztof, et al. "Personality-Based Affective Adaptation Methods for Intelligent Systems." Sensors 21.1 (2021): 163.

[13] Kuikkaniemi, Kai, et al. "The influence of implicit and explicit biofeedback in first-person shooter games." Proceedings of the SIGCHI conference on human factors in computing systems. 2010.

[14] Flying Mollusk, CA, USA, Nevermind, 2015.

[15] Vachiratamporn, Vanus, et al. "An analysis of player affect transitions in survival horror games." Journal on Multimodal User Interfaces 9.1 (2015): 43-54.

[16] Parsec Productions, NM, USA, Slender: The Eight Pages, 2012.

[17] Ng, Yiing, Chee Weng Khong, and Robert Jeyakumar Nathan. "Evaluating affective user-centered design of video games using qualitative methods." International Journal of Computer Games Technology 2018 (2018).

[18] Media Molecule, Guildford, UK, LittleBigPlanet 2, 2011